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EXPERIENCES WITH A NEW TYPE OF DAIRY WASTE TREATMENT

Progress Report of the Sanitary Engineering Research Committee, Industrial Waste Section

SANITARY ENGINEERING DIVISION

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THIS PAPER

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SED RESEARCH REPORT NO. 4

ON	EXPERIENCES WITH A NEW TYPE OF DAIRY WASTE TREATMENT
BY	The Sanitary Engineering Research Committee Industrial Waste Section.
From Research Data of	Dr. K. L. Schulze, Department of Civil and Sanitary Engineering, Michigan State University, East Lansing, Michigan

Synopsis: The design of a new two-stage aerobic treatment plant using the Cavitator aeration system is described, and the results obtained in treating the waste from a cheese factory at Hilbert, Wis., are presented.

INTRODUCTION

The treatment of dairy wastes, especially cheese wastes, presents many problems of an economic and engineering nature. Because these wastes have a high biochemical oxygen demand, the receiving body of water is frequently too small to handle the load by dilution. Consequently, the degree of treatment must be high in order to avoid nuisance conditions. On the other hand, a high degree of treatment usually requires a costly treatment system, which the average dairy plant cannot afford. Operation and maintenance are additional problems to be considered, particularly since many smaller factories have no personnel available to operate the treatment plant.

The ideal dairy waste treatment plant therefore should be relatively inexpensive, should provide a high degree of treatment, and should operate without special attention. For a number of years, engineers have tried to develop a plant to meet these requirements. Operation of a pilot plant of novel design was started in 1952, and results of the preliminary tests have been reported in a paper presented at the Ninth Industrial Waste Conference, Purdue University, May 1954. The full-scale plant went into operation in 1953.

Design of the Full-Scale Plant

The basic design of the commercial plant was not changed from the pilot plant. The screened raw waste enters a storage tank of approximately 6000-gallon capacity, and is then pumped at a constant rate to the first aeration tank. Waste flows by gravity into the downdraft of the second aerator and thence to the clarifier. The aeration tanks are round wooden vats containing 3000 gallons each. The circular clarifier has a capacity of 1100 gallons. Settled solids collect in the sludge hopper and are in part returned to the first aeration tank by a small pump, at a rate of about 2 gallons per minute. A portion of the sludge is wasted to a sand bed once a day; this quantity is from 100 to 200 gallons per day. The clarifier effluent goes to a sampling box connecting with an overflow line to the creek. The sampling box is also connected with the storage tank by a recirculation line. This line is controlled by a float valve, and as long as raw waste flows into the plant, the valve remains closed so treated effluent discharges to the creek. When the flow is discontinued (during the night) the liquid level in the storage tank goes down; when a predetermined level is reached the float valve opens, returning final effluent

to the storage tank. In this manner a recirculation and additional treatment is accomplished during the night hours.

The aeration equipment consists of two Cavitators, developed by the author in cooperation with Yeomans Brothers Company. Atmospheric air is drawn in through a rotating hollow shaft and down into several rotor arms. The quantity of air circulated through the Cavitator is measured by connecting the hollow shaft through a rotary seal to an air metering instrument such as a Fischer and Porter 'Flowrator.' When the nozzles at the end of the arms exceed a certain critical speed, they create a zone of cavitation in their turbulent trail and the air moves in to fill these volumes of reduced pressure. The moment air leaves the nozzles, it undergoes rapid changes in pressure and is finely dispersed by turbulence. The result is a high degree of oxygen transfer into the liquid. The nozzles are of ample size to eliminate any danger of clogging.

Results

The results obtained during the months of December, 1954, and January, 1955, are given in the following table:

AEROBIC CHEESE WASTE TREATMENT (1954/55)

Operating conditions: Two-stage Cavitator system.
Aeration Tank capacity: Two tanks of 3000 gallons each.
Air supply: 36 c.f.m. or 52,000 cu. ft. per day.
Motor: 5 Hp. each.
Raw feed rate: 5 - 8.3 g.p.m. continuously.
Clarifier capacity: 1100 gal.
Sludge return: 1 - 2 g.p.m. continuously.
Sludge removal: 100 - 200 gal. per day.

Raw B.O.D. p.p.m.	Pumpage gal./day	Load lb. B.O.D. /day	Eff. B.O.D. p.p.m.	B.O.D. Removal %	Air Supply /lb. B.O.D. /day cu. ft.	Aer. Tank Capacity cu. ft./lb. B.O.D.	Det. Period in Cavitator Hours
960	7200	58.0	12	98.7	900	13.8	20.0
1260	7200	76.0	18	98.6	685	10.5	20.0
840	11200	78.5	15	98.0	660	10.2	12.8
1380	7200	83.0	12	99.2	625	9.6	20.0
1110	9500	88.0	15	98.6	590	9.1	15.0
1170	9500	93.0	18	98.5	560	8.6	15.0
1150	11200	108.0	63	94.5	480	7.4	12.8
1200	12000	120.0	15	98.7	435	6.7	12.0
2220	7200	133.0	102	95.4	390	6.0	20.0
2370	7200	142.0	45	98.1	366	5.6	20.0
1530	12000	153.0	60	96.1	340	5.2	12.0
2040	12000	170.0	129	93.6	305	4.7	12.0

The figures have been arranged according to the load on the plant in pounds of BOD per day. The effluent shows a high degree of treatment, with a BOD below 20 ppm except at loadings exceeding 120 pounds of BOD per day. At high loading, the effluent BOD increases to 60 and 129 ppm, even though the BOD removals are still 96 and 94 percent respectively. It seems, therefore, that, up to a load of 120 pounds of BOD per day, this size of plant can handle

the waste very efficiently, delivering a final effluent that can safely be discharged even into a small creek.

With loads over 120 pounds of BOD per day, air supply is apparently the limiting factor. Referring to column 6 of the table, the air supply per pound of BOD dropped from 900 to 305 cubic feet as the load increased from 58 to 170 pounds of BOD. From these data it appears that approximately 400 cubic feet of air per pound of BOD per day is required to accomplish 98 percent BOD removal. This is in agreement with the results previously reported at the Purdue Conference.

These data indicate that 6-7 cubic feet of aeration tank capacity per # BOD and a 12-hour detention time are sufficient for treatment with the Cavitator system. The power requirement of 10 HP for loadings up to 120 pounds of BOD per day is economical when compared with the types of treatment now available to the dairy industry. Bulky sludge sometimes caused difficulties in plant operation; the main reason for this condition seems to be overloading.

Credit: This research report, which is one of a series of professional contributions by the Committee on Sanitary Engineering Research,

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